Renewable and Sustainable Energy Reviews 15 (2011) 2299–2309

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Analyzing Chinese consumers' perception for biofuels implementation: The private vehicles owner's investigating in Nanjing

Yong Zhang[a,*], Yifeng Yu[b,1], Tiezhu Li[a,2], Bai Zou[a,3]

[a] *School of Transportation, Southeast University, Jiangsu, Nanjing, 210096, China*
[b] *School of Industrial and Systems Engineering, Georgia Institute of Technology,755 Ferst Drive, Atlanta, GA, USA*

ARTICLE INFO

Article history:
Received 19 October 2010
Accepted 28 January 2011

Keywords:
Biofuels
Consumer perception
Private vehicle drivers
Factor analysis
Cluster analysis
China

ABSTRACT

The aim of this paper is to analyze consumers' awareness and attitudes towards biofuels implementation in road transportation sector of China with respect to different consumption groups. Firstly, the status and future trends have been reviewed, which focuses on the private vehicles development, energy demands of road transportation sector and biofuels. Furthermore, a comprehensive survey has been conducted for 374 private vehicle drivers (owners) in Nanjing. A questionnaire survey method is implemented to collect information including respondents' awareness, brief of biofuels, selection attitudes to biofuels and views on policies. Furthermore, the biofuels selection motives of respondents have been concluded into two main factors, "purchasing pressures" and "product attraction". Then the respondents were divided into three clusters and compared.

The results indicate that 90% of the respondents need to know more about biofuels implementation, and the majority of the respondents emphasize the active significance of reducing GHG emissions to improve energy security and mitigate energy crisis. But 55.6% of the respondents think that biofuels technology is still not mature. It is found that the different perceptions of biofuels between 192 passenger vehicle drivers (PVD) and 182 freight vehicle drivers (FVD). The former focuses on fuel price and fuel performance, while the latter pays more attention to fuel availability. Besides, PVD concentrate on fuel-related attributes while FVD focus on policy-related factors. The survey results give rise to some deeply consideration about the various preferences and awareness on biofuels among different consumer groups. These findings in this study will help to understand the consumer's energy consumption behaviors and improve the further implementation for biofuels in Nanjing city.

Contents

* Corresponding author. Tel.: +86 25 8379 5384; fax: +86 25 8379 5384.
E-mail addresses: zhang7678@126.com (Y. Zhang), yyu66@gatech.edu (Y. Yu), litiezhu@seu.edu.cn (T. Li), 74527593@qq.com (B. Zou).
[1] Tel.: +1 404 660 6857.
[2] Tel.: +86 25 8379 0839; fax: +86 25 8379 0839.
[3] Tel.: +86 25 8379 5384; fax: +86 25 8379 5384.

1364-0321/$ – see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.rser.2011.02.004

1. Introduction

1.1. Research background

In 2007, transport sector was responsible for 23% of the world total CO_2 emissions, as compared with 20% in 1971 [1]. In China, transport sector is the most rapidly growing sector in terms of energy, particularly oil demand and GHG emissions [2]. Although, in comparison with most other countries, the share of CO_2 emissions emanating from the transport sector in China is low, with 6% and 8% of all CO_2 emissions coming from the sector in 1990 and 2000 respectively [3]. However, considering the development path of the transport sector in developed countries, there is no doubt that road transport sector will become dominant in China's emissions inventories in the near future [4]. In particular, rapid growth of private vehicles has resulted in continuing growth in demand and imports of China's oil, which has been widely accepted as a major factor affecting future oil availability and prices and a major contributor to the increase China's GHG emissions [5].

Chinese government is making great efforts to control petroleum demand and GHG emissions in the road transport sector by introducing alternative fuels and regulating vehicle fuel economy. It has been acknowledged that the use of biofuels is the only feasible option for the substitution of fossil fuels in the transport sector [6]. Biofuels will be one of strategic measures to concern over climate change and energy security, which has been widely acknowledged in China. In 2006, China' National Development and Reform Commission (NDRC), as chief planning agency, set a target of achieving 15% of transportation energy needs with biofuels by 2020. Since 2003, Government began to greatly promote biofuels industry and market penetration, such as E10.

Although the significance of biofuels implementation in road transport sector is acknowledged, while it still represent a minor proportion of total fuel consumption in the world, such as biofuels contributing 1% of the world's road fuel consumption in 2006 [7]. Compared with some developed countries or regions such as Europe, US and Brazil, the biofuels' share is lower in China, which is not up to 1.5% of total energy consumption now. Barriers of bioenergy technology implementation have received increasing attention in recent years [8]. Based on many past studies [8–12], there are various obstacles and critical factors for different countries to promote biofuels implementation in road transport sector. To raise biofuels shares of road transport sector is a complexly systematic program, which is of various conditions in different countries or regions.

In most African countries, it is a critical hurdle for the market penetration of biofuels because the poor-educated public can hardly influence the government to begin to take more decisive initiatives in enhancing the development, application, dissemination of biomass energy resources and technologies in the national energy market [10]. As one of the strategic measures of Chinese road sector' GHG mitigation, it is important to understand the needs of biofuels market. Although some successful efforts have been got since 2003, there are still many difficulties in biofuels penetration in road transport sector of China. Like other green products' market penetration, one of the key challenges is to promote consumers' acceptance of biofuels. Many studies have suggested that the consumers' acceptability of biofuels in road sector will play a key role in promoting biofuels implementation [9,13].

1.2. Literature review

In essential, the biofuels is considered as one of the green technologies, which will help to improve environment profits and effects. Many studies have indicated that firm-related motives, threat of regulation and green consumerism are the main drives for the adoption of green technologies and products [14,15]. It is not only important to consider the green technology supply perspectives, but also to understand the consumer demand perspectives. Furthermore, understanding consumers' attitudes towards green technologies and their end products is helpful to promote customers to buy green products [16,17].

Susana Mourato et al. [16] suggests that the socio-economic characteristics (e.g. sex, age, family size, education, income, awareness, driving habit) will directly have impact on transportation energy selection. It is worth to note that demand may be influenced by peoples' notions of the impact of increased biofuels use on issues of national importance [18]. Research about biofuels acceptance by fuel consumers and consumers' beliefs on biofuels may tell market players about whether or not use certain propositions in their marketing and communication strategy to the general public and, in particular, to potential end users [17,19].

Main literatures about biofuels implementation have mostly discussed the supply perspectives relating to the product capacity and feedstock, biofuels technologies, policies and etc. But the end consumers' importance has not still been enough emphasized. Only little research has focused on this critical topic of biofuels implementation. For examples, Van de Velde et al. [17] investigated the beliefs of Belgian consumers' concerning the use of biofuels and identified four consumer segments based on the perceived importance of different fuel characteristics; Skipper et al. [20] has administered a survey to compare consumer perceptions regarding the tradeoff between renewable fuels and food in the United States (U.S.) ($n = 242$) and Belgium ($n = 363$); Popp et al. [19] has examined factors that influence the importance consumers place on fuel economy, with attention given to differences between American and European consumers. Moreover, Savvanidou et al. [21] has examined the public acceptance of biofuels in Greece. And Delshad et al. [22] explored detailed public attitudes regarding the expanding range of biofuels technologies and policy options in U.S.A. van Vliet et al. [23] formalized and parameterized a model for the production of six transport fuels and six fuels blends from six feedstocks through 13 different production chains, and their adoption of by 11 distinct subpopulations of motorists. They have found that adoption of specific fuels is mostly driven by price differences, but other factors play a role if prices are similar.

In China, majority of previous studies about biofuels implementation also mainly focus on the feedstock resources supply [24,25], conversion technologies [26,27], land resources [28,29], biofuels supply chain coordination [30–32] and no works related to the Chi-

nese consumer' awareness towards biofuels has been published in recent years.

1.3. Research objectives and scope

Nowadays, there are many regions in China, where biofuels has been still not widely implemented, such as Nanjing city. Although the use of biofuels is mandated by the government and end consumers have no choice at their preferred blend levels and typically are unable to express their preferences at the pump [18], we have noted that understanding the consumer consciousness based on the previous studies will bring with significant roles in biofuels market penetration in China in the future. In addition, the past studies about biofuels adoption in other countries or regions are not feasible for Chinese situation.

In order to cover the gap, the main objective of this paper is to understand the private vehicles owners' consciousness about biofuels implementation in road transportation of China. The creative work is to compare the different views from various customer segmentations in China road transport sector. The difference has not been studied in the same literature as before. A survey has been conducted in Nanjing city to study private vehicles owners' consciousness about biofuels. In this study, we have investigated two main groups of private vehicle owners: passenger vehicles drivers (owners, PVD), referring to the vehicles for household trip, not for commercial activities; freight vehicles drivers (owners, FVD), whose vehicles are used for commercial goals. Furthermore, the diversity of the two types of drivers' views on biofuels implementation have been analyzed and compared. Then factor analysis and cluster analysis are used to segment all the respondents based on biofuels selection motives. We tend to find some valuable conclusions and remarks, which will promote the biofuels implementation in future energy alternative strategy of road transport sector in China.

2. Biofuels implementation status in China

2.1. Private vehicle development and road transport energy demand

With rapid development of society and economy, there is an increasing trend of the motorization in China [2,33]. From 1990 to 2007, the average annual growth rate for private vehicle was 81%. Especially, the total number of private passenger vehicles in China rose by 962.6%, up to 23.1691 million and doubled from 2004 to 2007, which aligned with the encouragement policy for private ownership of vehicles in China. By comparison, private freight vehicle numbers have increased by 9.385 times in the same period, far below the growth rate of the private passenger vehicles. Fig. 1 shows the density of private vehicles per 1000 of people, which has increased from 0.714 to 21.768 between 1990 and 2007. If this current pattern continues, by the year 2030, the number of vehicle people in China will be 400 million [11].

With the rapid development of the private vehicles, China has become a net oil importer since 1993, and has been the second largest energy consumer now. Oil consumption has reached 346 million tons in 2007 with growth rate of 61%, higher than that in 2000, which took up about 9% of total oil consumption of the world [11]. Like many other countries in the world, Chinese demand for transport fuels has risen faster than total energy demand during the past few decades. Total transportation energy use is predicted to rise by more than 396 million tons from 2004 to 2030, and transportation's share of the total use of liquid fuels from 32% in 2004 to 47% by 2030 [11]. Oil consumption of the road transport sector has risen at an average annual rate of 9.6%; about 85% of gasoline and 42% of diesel are consumed by motor vehicles [11]. He et al. [4] has projected that the annual oil demand of China's road vehicles will reach 363 million tons by 2030.

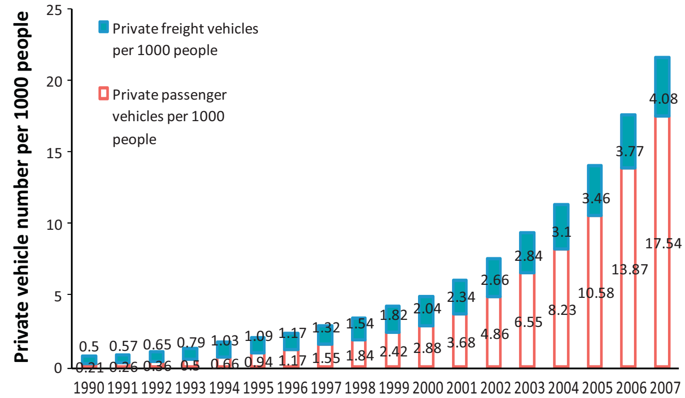


Fig. 1. Private vehicle number per 1000 people in China.

2.2. Biofuels production and market penetration status

Biofuels has gained increased interest worldwide due to concerns over climate change and energy security, and energy security appears to be the key reason for majority of the Asian countries' involvement in biofuels [7]. In the Medium-term and Long-term Development Strategies for Renewable Energy, Chinese government is planning to increase the current annual fuel ethanol production capacity from 1 to 3 Mt by 2010 to 10 Mt by 2020, and to establish biodiesel production capacity from 0.2 Mt by 2010 to 2 Mt by 2020 [2]. In the recent years, biofuels industry has achieved a great development in China. The production of bioethanol and biodiesel is described in Fig. 2.

Since 2003, gasoline (E10) (10% ethanol and 90% gasoline) has being promoted in road transport sector of China. By April 15th of 2008, there have been eleven provinces using ethanol-gasoline with ethanol percentage in the fuel of 10% (E10) in China. And six provinces have implemented in whole province, such as Jilin, Heilongjiang, Liaoning, Anhui, He'nan and Guangxi. The other five provinces have implemented in some cities, such as Hubei (Wuhan, Xiangfan, Jingmen, Suizhou, Xiaogan, Shiyan,Yichang, Huangshi and E'zhou), Hebei (Handan, Shijiazhuang, Baoding, Xingtai, Cangzhou and Hengshui), Shandong (Ji'nan, Ji'ning, Tai'an, Heze, Liaocheng, Zaozhuang and Linyi), and Jiangsu (Xuzhou, Yancheng, Lianyungang, Suqian and Huai'an). The bioethanol products are supplied by six producers, such as Heilongjiang Hua-run Alcohol Co. Ltd., Jilin Fuel Ethanol Co. Ltd., Henan Tianguan Enterprise Group Co. Ltd., Anhui BBCA Biochemical Co., and Guangxi COFCO Bio-energy Co. Ltd. [34].

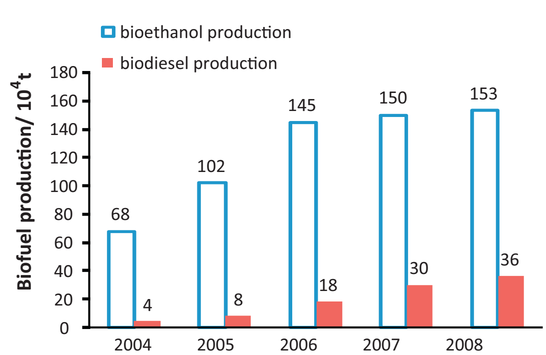


Fig. 2. Biofuels production in China [34,35].

Table 1
Demographic information of the surveyed private vehicles drivers in Nanjing.

	PVD		FVD		Total characteristics	
	Frequency	%	Frequency	%	Frequency	%
Age						
30 years	53	27.6	13	7.1	66	17.6
30–40 years	73	38.0	74	40.7	147	39.3
40–50 years	50	26.4	84	46.2	134	35.8
50 years	16	9.0	11	6	27	7.3
	192	100	182	100	374	100
Gender						
Male	120	62.5	171	94	291	77.8
Female	72	37.5	11	6	83	21.2
	192	100	182	100	374	100
Education						
Did not complete high school	6	3.2	25	13.7	31	8.3
High school graduate	87	45.3	157	86.3	244	65.2
Bachelor's	74	38.5	0	0	74	19.8
Graduate	25	13.0	0	0	25	6.7
	192	100	182	100	374	100
Average income						
RMB 20000 yuan	8	4.2	34	18.7	42	11.2
RMB 20000–50000 yuan	63	32.8	108	59.3	171	45.7
RMB 50000 yuan	121	63	40	22	161	43.1
	192	100	182	100	374	100

Compared with the widely implementation of bioethanol in China, biodiesels has not been widely promoted. But some implementation practices have been conducted in road transport fields such as public transport sector, private freight owners, school fleets and so on. At present, the widely implementation are not feasible because of many factors including laws, product capacity, market incentives and etc.

Currently, gasoline and diesel are two main fuels for vehicles in the metropolitan area of Nanjing, as the situation in most regions in China. Alternative fuels, such as biofuels, have not received much attention from the public. However, now there is enough motivation for biofuels implementation in Nanjing, because the government of Jiangsu Province is going to promote biofuels in the whole province. According to the plan, biofuels (E10) will be applied widely in Nanjing by 2010. In order to make suitable strategies and promote patterns for biofuels implementation, it is important and necessary to know consumers' perception for biofuels.

3. Material and methods

3.1. Data collection

Data collection on private car drivers' beliefs was carried out by questionnaires from 2008 to July 2010. Three fuel stations and two freight transportations stations were randomly selected in the area of Nanjing city. 600 questionnaires were distributed among people who filled up the vehicles in these stations. Given the length and the methodology of the survey, 374 questionnaires were useful for analysis at the end of the survey (the valid response rate was 62.3%). 374 drivers surveyed were all the owners of the vehicles for passengers or freight transportation. Every driver was asked to provide social-demographic information as reported in Table 1.

3.2. Questionnaire design

The structured questionnaire was developed and adapted from previous literature [14,15,17,19,20]. There were four parts in the questionnaire in accordance with reflecting respondents' awareness and attitudes about biofuels. The questionnaire was evaluated by three professors and two professional experts from Southeast University.

In the first part of the survey, familiarity and awareness with biofuels were measured. Respondents were asked whether they had head of or purchased biofuels. Furthermore, Respondents were asked to indicate to what extent they agreed that biofuels meet the following characteristics (9 items) by using "disagree", "agree" and "I didn't know it" including biofuels technologies, reduction GHE emissions, benefits for energy security, using characteristics etc.

In the second part of the questionnaire, participants were asked to indicate the degree of importance of 8 different fuel characteristics related to their purchasing new car or fuel consumption. A 5-point Likert scale from "not at all important (1)" to "very important (5)" was used to measure the perceived importance of fuel characteristics such as price, expected vehicle performance, maintenance costs, adaption (engine-modification requirements), availability at fuel stations, consumption habits and fuel supply providers.

In the third part of the survey, respondents were asked to indicate the degree of importance of 9 various motives which can promote them to purchase biofuels by using the same 5-point Likert scale. The various motives were given as follows: attraction of fuel price, fuel performance satisfactory, improvement in biofuels service network, market attraction of alternative fuel technology, trying on new fuels, reduction motive in environmental pollution, influence of friends, requirement of changing fuel by law or regulation and tax incentives for purchasing alternative fuel.

Lastly, participants were asked to indicate to what extent they agreed that the following measures (8 items) would promote biofuels implementation in the road transportation in China by using a 5-point Likert scale ["strongly disagree (1)", "disagree (2)", "neutral (3)", "agree (4)", "strongly agree (5)"]. The promoting measures were accordance with biofuels plan, biofuels supply chain coordination, laws, incentives and technologies improvement and so on.

3.3. Statistical analysis

Data were coded and analyzed with SPSS 16.0. Frequency tables were used and Chi-Square Tests were conducted. And Cronbach's alpha coefficient was used for verification of construct reliability. Moreover, Principle Component Analysis as extraction method was used for factor analysis, and K-shortest method was used to classify these drivers into various clusters. These statistics methods

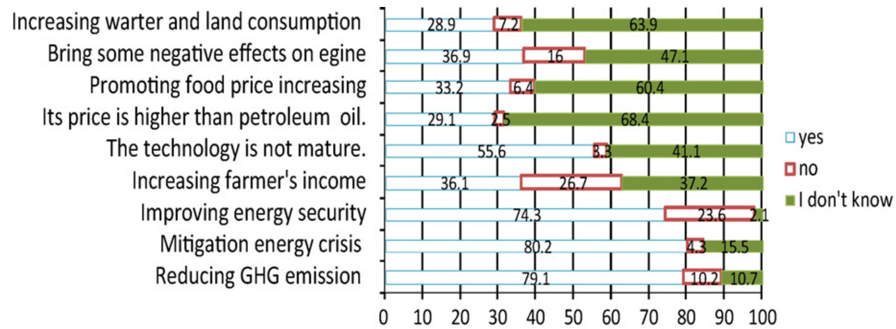


Fig. 3. Beliefs about biofuels, frequency distribution, % ($n = 374$).

were carefully applied in light of the introduction in the literature [36].

4. Results and discussion

4.1. Topic 1: drivers' awareness and brief on biofuels

Because biofuels have not been supplied in the fuel station in Nanjing, the majority of the respondents are lack of using experiences of biofuels. 93% of respondents have never utilized E10 or biodiesels. And 81% of the respondents have known about some relative information of the biofuels, but the results suggest above 90% of them need to know more about biofuels implementation for future. The results of this study are different from other past studies. The research [37] suggest that nine out of ten UK citizens are not well informed about biofuels, while only 55% know what biofuels is. Lahmann [38] has shown that 60% are very or somewhat knowledgeable about biodiesel. Another study shows that only 56% of respondents have a high to very high knowledge about ethanol and biodiesel in Canada [39]. Fig. 3 described the briefs for biofuels of the respondents.

80.2% of the respondents address that biofuels will help to mitigate energy crisis, higher than that in Greece (53.9%) [21]. And 79.1% of the respondents suggest biofuels will reduce GHG emission, which is 49.9% in Greece [21] and lower than that in Belgium (83.2%) [17]. At the same time, 74.5% of the respondents agree that biofuels will improve energy security. There are different viewpoints whether biofuels increase farmers' incoming. The majority of the respondents do not known well about biofuels' price information, effects on vehicle engine and foods, water and land consumption. As a whole, 55.6% of the respondents think the biofuels technology is still not mature, which is close to 64.1% in Belgium [17].

4.2. Topic 2: drivers' preference for fuel characteristics

Clearly, consumers' cognition of fuels for vehicles can reflect the difference of consumers' demand. Table 2 displays consumers' opinions on different attributes of fuels.

For the whole 374 drivers, the orders of comparative importance of all the 8 factors are: engine modification, fuel availability, environmental effects, fuel-provider type, consumer habits, fuel performance, maintenance cost and fuel price. Obviously, for PVD, the orders of importance for all the 8 factors related to selecting new vehicles are: engine modification, fuel performance, fuel price, environmental effects, fuel availability, maintenance cost, fuel-provider type, consumer habits. As to FVD, the orders are fuel availability, engine modification, fuel-provider type, environmental effects, consumer habits, maintenance cost, fuel performance, fuel price. The results of these topics are different from other similar research, such as Van de Velde et al. [17].

Table 2
Drivers' considering fuels preferences about when they select new vehicles.

Factors[a]	Not at all important (%)	Unimportant (%)	Neutral (%)	Important (%)	Very important (%)	Mean (S.D.)	Rank	Chi-square tests
Fuel price	0	1.9	32.6	36.9	28.6	3.9225 (0.6830)	8	111.84
PVD	0	3.1	16.1	38.5	42.2	4.1979 (0.8200)	3	79.542
FVD	0	0.5	50	35.2	14.3	3.6319 (0.05408)	8	104.901
Fuel performance	0	1.3	24.9	43.6	30.2	4.0267 (0.6050)	6	139.497
PVD	0	1.6	19.8	34.9	43.8	4.2083 (0.8114)	2	78.792
FVD	0	1.1	30.2	52.7	15.9	3.8352 (0.5141)	7	105.604
Maintenance cost	0.3	1.9	28.6	36.1	33.2	4(0.7180)	7	228.941
PVD	0.5	3.6	22.4	31.3	42.2	4.1094 (0.9115)	6	122.063
FVD	0	0	35.2	41.2	23.6	3.8846 (0.05634)	6	8.714
Engine modification	0	0.3	13.4	50.3	36.1	4.2219 (0.457)	1	225.679
PVD	0	0.5	9.4	48.4	41.7	4.3125 (0.6602)	1	128.292
FVD	0	0	17.6	52.2	30.2	4.1264 (0.05052)	2	33.505
Fuel availability	0.3	0.8	16.6	48.7	33.7	4.1471 (0.539)	2	332.604
PVD	0.5	1.6	18.8	43.8	35.4	4.1198 (0.8002)	5	146.177
FVD	0	0	14.3	53.8	31.9	4.1758 (0.04878)	1	42.901
Environment effects	0.3	2.4	16	46.5	34.8	4.1310 (0.613)	3	305.920
PVD	0.5	3.1	12.5	45.3	38.5	4.1823 (0.8078)	4	163.677
FVD	0	1.6	19.8	47.8	30.8	4.0769 (0.05590)	3	81.956
Consumer habits	0.5	2.9	21.7	42.2	32.6	4.0348 (0.7090)	5	248.112
PVD	1	5.7	15.6	39.6	38	4.0781 (0.9261)	8	123.885
FVD	0	0	28	45.1	26.9	3.9890 (0.05590)	5	11.286
Fuel providers	0.5	3.2	16.6	46.3	33.4	4.0882 (0.670)	4	288.380
PVD	1	6.3	13.5	40.1	39.1	4.099 (0.9298)	7	130.344
FVD	0	0		52.7	27.5	4.0769 (0.05077)	3	32.484

[a] Cronbach's alpha coefficient for all respondents = 0.703.

- 38.5% and 42.2% of the drivers of passenger cars consider fuel price as “important” and “very important” respectively. In contrast, the majority of freight vehicle drivers (FVD) (50%) only choose “neutral” on this option. The difference of fuel price between these two groups (0.566) is larger than that of any other attribute. This obviously shows that passenger vehicle drivers (PVD) are more sensitive to fuel price.
- As to fuel performance, 43.8% of PVD choose “very important”, followed by 34.9% of the respondents that select “important.” But the two largest groups of FVD choose “important” (52.7%) and “neutral” (30.2%), with only 15.9% considering fuel performance as “very important’. The mean of PVD (4.2083) is also considerably larger than that of FVD (3.6319).
- The mean of maintenance cost for PVD is also higher than that for FVD. The largest group of PVD (42.2%) consider maintenance cost to be “very important”, while that of FVD (41.2%) choose “important”. However, it should be noted that both PVD and FVD have not placed great emphasis on maintenance cost, as the mean of maintenance cost for PVD only ranks 6th in the mean of all the 8 attributes, with the same situation in the group of FVD.
- It can be clearly revealed in the table that both PVD and FVD regard engine modification as crucial. 90.1% of the PVD and 82.4% of the FVD choose “important” or “very important” for engine modification. Compared with the mean of other attributes, the mean of engine modification for PVD (4.3125) ranks first among all the means for this group, and that for FVD (4.1264) ranks second. The high expense for engine modification in China may account for this survey result.
- As to fuel availability, it is worth mentioning that the mean for FVD (4.1758) is higher than that for PVD. Since freight vehicles are usually for commercial use and are often featured by long-distance trip, fuel availability becomes comparatively important for FVD. In Table 2, 81.3% of the PVD’ average trip distance is no more than 50 km/day. As a result, fuel availability is not a priority for PVD. However, Romm [40] indicates that the refueling availability is one of the six major barriers to the success of alternative fuel implementation.
- With rising awareness of environmental problems in whole society, respondents in this survey also show their concern for this problem. 45.3% of PVD and 47.8% of FVD choose “important’ for environmental effects, as well as 38.5% and 30.8% of the two groups respectively select “very important” for this question. However, it is difficult to know whether these drivers’ attitude will actually be translated into real market behavior.
- As to consumer habits, although the mean for PVD is higher than that for FVD, it should be noted that the mean for PVD ranks the last in all 8 means for this group, while that for FVD ranks the sixth.
- The survey result for fuel-provider type is similar to that of consumer habits. The mean for PVD is higher than that for FVD. But as to the ranking among all the means, that for FVD (3rd) is higher than that for PVD (7th).

From the orders of all the 8 factors for the two types of drivers, difference in the importance of some factors can be revealed. Compared with PVD, FVD focus on fuel availability, which is the most important factor for them. And fuel price is the least important factor for FVD. However, PVD pay more attention to fuel performance and fuel price. In addition, FVD also place more emphasis on fuel-provider type and consumer habits than PVD. This reflects that PVD are less influenced by their driving habits and their choices are more rational. Since freight vehicles are always for commercial use and fuel cost only makes up a small portion of freight transportation company’s operational cost, FVD are less sensitive to fuel price and more sensitive to fuel availability. In the survey, private car owners make up a large portion of PVD. Because fuel cost constitutes a considerable portion of PVD’ expenses on vehicles, they tend to display high sensitivity to fuel price. Besides, PVD in the survey are generally more educated than FVD, which may also lead to the difference in survey results of the two groups.

However, PVD and FVD also show some similarities in the survey. As previously mentioned, the two groups both emphasize the importance of engine modification. Besides, PVD and FVD both regard environmental effects of vehicles as significant. However, as mentioned above, this result should be understood with caution.

4.3. Topic 3: drivers’ selection motives about biofuels implementation

From the studies [14,15], perspectives of biofuels of supply side and demand side will affect consumer’ adoption. In above topic, the respondents were asked “which characteristics are important?”. It is only relative biofuels product characteristics. In this part we have asked drivers which factors will take a role to apply biofuels, which means that why do the respondents accept the biofuels. Table 3 shows the survey results about drivers’ selection attitudes about biofuels implementation.

As to attraction of fuel price, approximately the same percentage of PVD and FVD respectively have chose “important”. However, the percentage of PVD who select “very important” is much larger than that of FVD. Similarly, there is also a higher percentage of PVD who have chose “very important” for fuel performance satisfactory and the improvement in biofuels service network than that of FVD. The increase in market attraction of alternative fuel technology is considered as a significant factor by both PVD and FVD, with the highest mean (4.2193) in all the 9 factors. In contrast, trying on new things is regarded as the least important factor and the mean (3.8663) is the lowest. Reduction in environmental pollution and influence of friends are considered comparatively unimportant, ranking 7th and 8th respectively in all the 9 factors. And the requirement of changing fuel by law or regulation is considered to be relatively important by FVD, although the percentage of PVD who have chose “very important” for this question is higher than that of FVD. The condition is similar to tax incentives for purchasing alternative fuel vehicles.

When the drivers were asked “what factors are important to attract them to use biofuels?”, the orders of relative importance of all the 9 factors are: the increase in market attraction of alternative fuel technology, the improvement in biofuels service network, the requirement of changing fuel by law or regulation, satisfactory fuel performance, tax incentives for purchasing alternative fuel vehicles, the attraction of fuel price, the reduction in environmental pollution, the influence of friends, trying on new fuels.

For PVD, the top three factors motivating them into using biofuels are the improvement of biofuels service network, the attraction of fuel price, the increase in market attraction of alternative fuel technology. The last factor is trying on new things, and factor ranks just before the last is the influence of friends. But for FVD, the top three factors are the increase in market attraction of alternative fuel technology, the requirement of changing fuel by law or regulation and tax incentives for purchasing alternative fuel vehicles. The last two factors are the attraction of fuel price and the reduction in environmental pollution. Similar to the findings in Germany and UK [41], the results confirm that the environmental reasons for purchasing biofuels are simply overshadowed by price and availability.

Clearly, the two types of drivers hold different opinions on the importance of the attraction of fuel price and the reduction in environmental pollution, with PVD focusing more on fuel-related attributes while FVD paying attention to policy-related factors.

Table 3
Drivers' selection motives about biofuels.

Motives[a]	Not at all important (%)	Unimportant (%)	Neutral (%)	Important (%)	Very important (%)	Mean (S.D.)	Rank	Chi-square tests
Attraction of fuel price	0	1.1	22.5	46	30.5	4.0588 (0.7552)	6	157.037
PVD	0	1	7.8	46.4	44.8	4.349 (0.6695)	2	131.875
FVD	0	1.1	37.9	45.6	15.4	3.7527 (0.7202)	9	91.363
Fuel performance satisfactory	0	0.5	22.7	42	34.8	4.1096 (0.7654)	4	147.69
PVD	0	0	17.2	35.9	46.9	4.2969 (0.7452)	4	25.969
FVD	0	1.1	28.6	48.4	22	3.9121 (0.7381)	5	82.879
Improvement in biofuels service network	0.3	0.3	20.6	40.1	38.8	4.1684 (0.7756)	2	287.176
PVD	0.5	0.5	10.9	39.1	49	4.3542 (0.7376)	1	196.125
FVD	0	0	30.8	41.2	28	3.9725 (0.7684)	4	5.286
Market attraction of alternative fuel technology	0	8	15.2	45.2	38.8	4.2193 (0.7249)	1	191.176
PVD	0	1.6	10.9	40.1	47.4	4.333 (0.7332)	3	113.417
FVD	0	0	19.8	50.5	29.7	4.0989 (0.6981)	1	26.945
Trying on new fuels	0.5	5.1	28.3	39.3	26.7	3.8663 (0.8868)	9	203.674
PVD	1	7.8	26.6	34.9	29.7	3.8438 (0.9743)	9	83.208
FVD	0	2.2	30.2	44	23.6	3.8901 (0.7859)	7	66.132
Reduction motive in environmental pollution	0	1.6	22.2	47.9	28.3	4.0294 (0.7551)	7	162.9
PVD	0	2.1	12	51	34.9	4.1875 (0.7209)	5	112.958
FVD	0	1.1	33	44.5	21.4	3.8626 (0.7564)	8	74.835
Influence of friends	1.3	3.7	20.1	42	32.9	4.0134 (0.8952)	8	235.947
PVD	2.1	5.7	14.1	41.7	36.5	4.0469 (0.9615)	8	124.823
FVD	0.5	1.6	26.4	42.3	29.1	3.97 (0.8207)	6	121.626
Requirement by law or regulation	0.5	2.7	15.8	47.1	34	4.1123 (0.8952)	3	303.674
PVD	1	5.2	12	42.2	39.6	4.1406 (0.8956)	6	145.76
FVD	0	0	19.8	52.2	28	4.0824 (0.6884)	2	31
Tax incentives for purchasing alternative fuel	0.8	1.3	18.7	46.5	32.6	4.0882 (0.7956)	5	295.706
PVD	1.6	2.6	13.5	45.3	37	4.1354 (0.8576)	7	154.875
FVD	0	0	24.2	47.8	28	4.0385 (0.7235)	3	17.549

[a] Cronbach's alpha coefficient for all respondents = 0.701.

4.4. Topic 4: drivers' views on promotion policies of biofuels implementation in Nanjing

In the last part, drivers were asked for their opinions on promotive policies for biofuel implementation. The survey results are given in Table 4.

For the whole 374 respondents, the three most effective policies are improving biofuels industry chain and forming reasonable benefit mechanism in order to reduce the cost; coordinating raw material supply, manufacturing and selling in order to form a unified biofuels supply chain; increasing subsidies for using biofuels to encourage green consumption. The three most ineffective policies are carrying out long-term regulations and policies for the development of biofuels; enhancing governmental support and promoting alternative fuel vehicle technology in order to form an advantage over traditional products; imposing fuel tax and emission tax on consumers in order to make them pay for environmental pollution. Obviously, PVD and FVD diverge on the relative importance of most policies.

- As to PVD, the three most effective policies for promoting biofuels implementation are coordinating raw material supply, manufacturing and selling in order to form a unified biofuels supply chain; carrying out long-term regulations and setting up supportive policies; increasing subsidies for using biofuels to encourage green consumption. The least effective policy is imposing fuel tax and emission tax on consumers in order to make them pay for environmental pollution, and the policy ranks just before is increasing the range of fuel crop selection and increasing supply reliability in order to commercialize the second generation of biofuels.
- For FVD, the top three policies are improving biofuels industry chain and forming reasonable benefit mechanism in order to reduce the cost of biofuels; improving the manufacturing technology of biofuels and enhancing its comprehensive performance; increasing the range of fuel crop selection and increasing supply reliability in order to commercialize the second generation of biofuels. The least effective policy they think is carrying out long-term regulations and policies for the development of biofuels and the policy ranks just before is enhancing governmental support and promoting alternative fuel vehicle technology in order to form an advantage over traditional products.
- As to carrying out long-term regulations and policies for the development of biofuels, PVD and FVD hold totally different opinions on this policy. The first group regard it as the second most important policy while the other group consider it to be the least effective policy. Enhancing governmental support and promoting alternative fuel vehicle technology in order to form an advantage over traditional products is considered as relatively unimportant by both groups. Coordinating raw material supply, manufacturing and selling in order to form a unified biofuels supply chain is a policy important for both groups, especially for PVD.
- As to increasing the range of fuel crop selection and increasing supply reliability in order to commercialize the second generation of biofuels, FVD think that this policy is comparatively important, while PVD consider it to be not very important.

Table 4
The respondents' viewpoints about how to promote biofuels implementation.

Measures[a]	Strongly disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly agree (%)	Mean (S.D.)	Rank	Chi-square tests
Carrying out long-term regulations and policies for the development of biofuels	0	0.8	33.2	37.2	28.9	3.9412 (0.8067)	8	121.936
PVD	0	1	13	41.1	43.8	4.2969 (0.7311)	2	105.208
FVD	0	0.5	54.4	33	12.1	3.5659 (0.7079)	8	123.187
Enhancing governmental support and promoting alternative fuel vehicle technology in order to form an advantage over traditional products	0	0.5	21.9	51.6	25.9	4.0294 (0.7074)	7	196.973
PVD	0	1	14.1	45.8	39.1	4.2292 (0.7233)	5	101.792
FVD	0	0	30.2	57.7	12.1	3.8187 (0.6264)	7	57.571
Coordinating raw material supply, manufacturing and selling in order to form a unified biofuels supply chain	0	1.1	17.4	41.7	39.8	4.2032 (0.7584)	1	169.08
PVD	0	2.1	12.5	36.5	49	4.3229 (0.7725)	1	106.5
FVD	0	0	22.5	47.3	30.2	4.0769 (0.7242)	5	17.484
Increasing the range of fuel crop selection and increasing supply reliability in order to commercialize the second generation of biofuels	0	0.8	19.3	46.8	33.2	4.123 (0.7365)	5	173.529
PVD	0	1.6	18.2	42.7	37.5	4.1615 (0.7726)	7	81.792
FVD	0	0	20.3	51.1	28.6	4.0824 (0.6963)	3	27.703
Imposing fuel tax and emission tax on consumers in order to make them pay for environmental pollution	0	2.4	19.5	44.1	34	4.0963 (0.78957)	6	147.54
PVD	0	4.2	17.7	39.6	38.5	4.1250 (0.8469)	8	67.833
FVD	0	0.5	21.4	48.9	29.1	4.0659 (0.7253)	6	87.275
Improving the manufacturing technology of biofuels and enhancing its comprehensive performance	0.3	0.8	16.8	46.5	35.6	4.1631 (0.7451)	4	320.439
PVD	0.5	1.6	12.5	45.3	40.1	4.2292 (0.7655)	5	174.771
FVD	0	0	21.4	47.8	30.8	4.0934 (0.7184)	2	19.527
Increasing subsidies for using biofuels to encourage green consumption	0.5	1.9	16.3	42.2	39	4.1738 (0.8050)	3	295.171
PVD	1	3.1	12.5	35.4	47.9	4.2604 (0.8712)	3	164.875
FVD	0	0.5	20.3	49.5	29.7	4.0824 (0.7197)	3	90.22
Improving biofuels industry chain and forming reasonable benefit mechanism in order to reduce the cost	0	1.6	15.5	43.9	39	4.2032 (0.7549)	1	178
PVD	0	2.6	12	43.8	41.7	4.2448 (0.7640)	4	99.875
FVD	0	0.5	19.2	44	36.3	4.1593 (0.7447)	1	81.341

[a] Cronbach's alpha coefficient for all respondents = 0.685.

- Imposing fuel tax and emission tax on consumers in order to make them pay for environmental pollution is revealed to be a comparatively ineffective policy, especially for PVD.
- As to the question of improving the manufacturing technology of biofuels and enhancing its comprehensive performance, FVD think that it is the second most important policy while PVD consider it to be comparatively unimportant. Increasing subsidies for using biofuels to encourage green consumption ranks 3rd and 4th respectively in all the 9 policies for PVD and FVD.
- Improving biofuels industry chain and forming reasonable benefit mechanism in order to reduce the cost of biofuels is regarded

Table 5
Results of principal components analysis of selection motives towards biofuels.

Components	Loadings[a]	%Variance explained	Cronbach's α
Component 1 (purchasing pressure) [b]		22.6	0.623
Trying on new fuels	+0.626		
Reduction motive in environmental pollution	+0.444		
Influence of friends	+0.661		
Requirement by law or regulation	+0.683		
Tax incentives for purchasing alternative fuel	+0.643		
Component 2 (product attraction) [b]		21.3	0.628
Attraction of fuel price	+0.741		
Fuel performance satisfactory	+0.776		
Improvement in biofuels service network	+0.541		
Market attraction of alternative fuel technology	+0.610		

[a] After varimax rotation.
[b] Variables with loadings less than 0.4 were omitted.

as the most important policy for FVD, with the mean of 4.1593. For PVD, attention is also paid to this policy, although it is not considered to be the most important one.

4.5. *Topic 5: Segmenting of the respondents' based on their selection motives*

In order to deeply analyze the respondents, in this part the respondents ($n = 374$) have been analyzed by using of factor analysis and cluster analysis based on selection motives for biofuels. Firstly, two new dimensions are found by using of principle component analysis as extraction method. The results of factor analysis are described in the Table 5. According to the highest loading in each dimension the labeling of new dimensions is as follows: Component 1, purchase pressure; Component 2, product attraction. The two Components together account for 43.9% of the initial variance (KMO = 0.758; Bartlett P-value = 0.000).

Although in the above part, the similarities and differences of awareness and attitude for biofuels are conducted between the PVD group and FVD group. However, it is necessary for decision-makers to realize and understand the common characteristics of various consumer groups from the selection motives of biofuels. Furthermore, in this paper, a cluster analysis is performed with two intensive factors. The K-shortest method is used to classify these drivers into various groups. Three different groups have been gotten, and the initial cluster centers are described in Table 6.

Table 6
Mean value of selection motives for biofuels per cluster.

Selection motives	Cluster 1	Cluster 2	Cluster 3
Purchasing pressures[a]	+0.102	+0.525	−1.916
Product attraction[a]	−0.781	+0.911	+0.405
No. of cases (%)	187 (50%)	139 (37.2%)	48 (12.8%)

[a] Significant differences between clusters with ANOVA P-value ≤ 0.05.

According to Table 6, three groups have great differences in the selection motives towards biofuels implementation. For cluster 1 (50% of the respondents), they greatly disagree that "product attraction" is the key factor, but agree with "purchasing pressure". For cluster 2 (37.2% of the respondents), they significantly agree that "product attraction" is the key factor, and also agree with "purchasing pressure". For cluster 1 and 2, they have great differences in "product attraction" and have some similar understanding of "purchasing pressure". Otherwise, for cluster 3 (12.8% of the respondents), they strongly disagree with "purchasing pres-

Table 7
Importance given to driver types, fuel preference and demographics per cluster.

Attributes		Cluster 1	Cluster 2	Cluster 3
Drivers[a] types (%)	FVD	69.3	25.9	31.1
	PVD	30.7	74.1	68.9
Fuel[a] preference, mean (S.D.)	Fuel price	3.57 (0.754)	4.40 (0.688)	3.92 (0.794)
	Fuel performance	3.72 (0.740)	4.44 (0.682)	4.04 (0.617)
	Maintenance cost	3.88 (0.824)	4.25 (0.799)	3.75 (0.911)
	Engine modification	4.05 (0.662)	4.43 (0.649)	4.27 (0.644)
	Fuel availability	4.12 (0.716)	4.35 (0.624)	3.67 (0.859)
	Environment effects	4.03 (0.761)	4.40 (0.634)	3.73 (0.984)
	Consumer habits	3.94 (0.749)	4.44 (0.661)	3.23 (0.973)
	Fuel providers	4.03 (0.729)	4.45 (0.628)	3.29 (1.010)
Age (%)[a]	30 years	12.8	20.1	29.2
	30–40 years	36.9	38.8	50
	40–50 years	43.3	32.4	16.7
	50 years	7.0	8.7	4.1
Gender (%)[a]	Male	86.1	61.9	70.8
	Female	13.9	30.9	29.2
Education[a] (%)	Did not complete high school	11.8	2.9	10.4
	High school graduate	75.9	54.7	54.2
	Bachelor's	8.6	32.4	27.1
	Graduate	3.7	10.0	8.3
Average[a] income (%)	RMB 20000 yuan	13.9	9.4	6.2
	RMB 20000–50000 yuan	50.8	39.6	43.8
	RMB 50000 yuan	35.3	51.0	50.0

[a] Significant differences between clusters with ANOVA P-value ≤ 0.05.

sure", and they feel "product attraction" is the factor which affects their biofuels adoption. We can see from Table 6 that the incentives will be effective to promote biofuels implementation only if the differences of the consumer perception are fully considered.

Furthermore, in order to distinguish the differences of three clusters, Table 7 described the driver types, fuel preference and demographics per cluster.

From Table 7, three clusters have been described from multiple perspectives. It is obvious that there are many differences in driver type, fuel preference and demographics per cluster. Some findings have been concluded from Tables 6 and 7 as following.

- Cluster 2 and cluster 3 are relatively easy to accept biofuels by improving biofuels attraction and creating market environment. But cluster 1 is hard to accept biofuels. So the various measures should be done according to their different effects.
- Education level and income maybe are two important factors, which affect the decisions of the biofuels consumption. In our research, the percents of higher education and income of cluster 2 and cluster 3 are more than the percent of cluster 1.
- There are some relations between fuel preferences and selection motives for per cluster. From Table 7, cluster 2 strongly agrees that every fuel characteristic is important for them to select some fuel.
- Majority of FVD belong to cluster 1 (72% of FVD), and 53.6% of PVD belong to cluster 2. It is suggested that the great difference between FVD and PVD should be considered before biofuels policies or measures are established.

5. Conclusions

The boost in the number of private vehicles increases the difficulty in energy supply in China, but it also provides opportunities for the development of biofuels. Promoting biofuels implementation in road transportation sectors in China is an important strategy for energy security and lowering emission of green-house gas [5]. Drivers, especially private vehicle drivers, have more independence in selecting fuels, thus their acceptance of biofuels will directly influence the implementation of biofuels. This paper introduces the development trend as well as energy demand of private vehicles and analyzes the current application of biofuels. Moreover, based on the survey for 374 private vehicle owners in the metropolitan area of Nanjing, the different conceptions for biofuels implementation have been compared with and differentiated among the respondents respectively in light of two ways including PVD and FVD, and cluster analysis from the perspective of selection motives for biofuels. In conclusion, some significant findings have been reached in this paper as follows:

- The boost in the number of private vehicles will undoubtedly increase energy consumption and emission of green-house gas, therefore creating more difficulties for solving the energy problem and climate problem in China.
- From the perspective of biofuels production and implementation, it is necessary to promote biofuels implementation in road transportation sectors in China, but should fully understand consumers' demand and acceptance in the specific region where biofuels is going to be promoted and should positively modify promotive strategy.
- As is shown in the survey results, PVD and FVD display differences in the relative importance of fuel-related factors and promotive policies for biofuels implementation. And the majority of the respondents are lack of usage experiences of biofuels. Above 90% of them need to know more about biofuels implementation for future. The results also suggest that comparing with other countries' consumer, there are many differences of Chinese perception to biofuels.
- For the respondents, the motives of biofuels selection are to be divided into two aspects such as "purchasing pressure" and "product attraction". And the respondents can be divided into three clusters according biofuels selection motives. When promoting biofuels implementation in the regions where biofuels has never been promoted so far, policy makers should fully consider consumers' preference for selecting fuels, their cognition level of biofuels and personal characteristics. Therefore differentiated promotive strategies should be made and carried out.
- Developing biofuels industry chain and improving its technology should be emphasized. In addition, a green-consumption atmosphere should be set up and laws as well as regulations for promoting biofuels implementation should be perfected. Furthermore, it is also important to improve biofuels performance and lower its cost. Each of these steps will promote biofuels implementation to some extent.

However, this paper provides us with more understanding about consumers' attitude towards biofuels and about how biofuels should be implemented in China. Compared with other literature on biofuels application in China, this paper investigates the problem of biofuels implementation from the perspective of consumers' attitude, which provides a new approach for improving the problem of biofuels implementation. But there are still some limitations in this paper, such as the bias in survey sample selection and the analysis of survey results. In the future, we plan to carry out surveys for consumers who live in the regions where biofuels has not been promoted so far, and the survey should cover a larger and more representative sample. Besides, some methods will be applied for quantitative analysis of consumers' biofuels-consumption behavior, which will increasingly uncover the mechanism of various factors' influence on the market acceptance of biofuels.

Acknowledgements

The authors are grateful to the strong support of mentors, whose constructive comments and suggestions have helped to improve the quality of the paper. This work is supported by National Natural Science Foundation of China (70902029, 50910105065) and Ph.D. Programs Foundation of Ministry of Education of China (20090092120045). We thank Cai Xiaohua, Gu Yuan and Xu Haixu for their supports about data collection and statistics analysis.

References

[1] IEA. CO_2 emissions from fuel combustion highlights. IEA; 2009.
[2] Yan X, Crookes RJ. Life cycle analysis of energy use and greenhouse gas emissions for road transportation fuels in China. Renewable and Sustainable Energy Reviews 2009;13:2505–14.
[3] Wang C, Cai W, Lu X, Chen J. CO_2 mitigation scenarios in China's road transport sector. Energy Conversion and Management 2007;48:2110–8.
[4] He K, Huo H, Zhang Q, He D, An F, Wang M, et al. Oil consumption and CO_2 emissions in China's road transport: current status, future trends, and policy implications. Energy Policy 2005;33:1499–507.
[5] Yan X, Crookes RJ. Reduction potentials of energy demand and GHG emissions in China's road transport sector. Energy Policy 2009;37:658–68.
[6] Peters J, Thielmann S. Promoting biofuels: implications for developing countries. Energy Policy 2008;36:1538–44.
[7] Zhou A, Thomson E. The development of biofuels in Asia. Applied Energy 2009;86:S11–20.
[8] Roos A, Graham RL, Hektor B, Rakos C. Critical factors to bioenergy implementation. Biomass and Bioenergy 1999;17:113–26.
[9] Steenberghen T, López E. Overcoming barriers to the implementation of alternative fuels for road transport in Europe. Journal of Cleaner Production 2008;16:577–90.
[10] Amigun B, Sigamoney R, von Blottnitz H. Commercialisation of biofuel industry in Africa: a review. Renewable and Sustainable Energy Reviews 2008;12(3):690–711.

[11] Hu X, Chang S, Li J, Qin Y. Energy for sustainable road transportation in China: challenges, initiatives and policy implications. Energy 2010;35(11):4289–301.
[12] Kent Hoekman S. Biofuels in the U.S. – challenges and opportunities. Renewable Energy 2009;34:14–22.
[13] Huang Y-H, Wu J-H. Analysis of biodiesel promotion in Taiwan. Renewable and Sustainable Energy Reviews 2008;12:1176–86.
[14] Wong V, Turner W, Stoneman P. Marketing strategies and market prospects for environmentally friendly consumer products. British Journal of Management 1996;7:263–81.
[15] Schulte I, Hart D, van der Vorst R. Issues affecting the acceptance of hydrogen fuel. International Journal of Hydrogen Energy 2004;29:677–85.
[16] Mourato S, Saynor B, Hart D. Greening London's black cabs: a study of driver's preferences for fuelcell taxis. Energy Policy 2004;32:685–95.
[17] Van de Velde L, Verbeke W, Popp M, Buysse J, Van Huylenbroeck G. Perceived importance of fuel characteristics and its match with consumer beliefs about biofuels in Belgium. Energy Policy 2009;37:3183–93.
[18] Petrolia DR, Bhattacharjee S, Hudson D, Herndon CW. Do Americans want ethanol? A comparative contingent-valuation study of willingness to pay for E-10 and E-85. Energy Economics 2010;32(1):121–8.
[19] Popp M, Van de Velde L, Vickery G, Huylenbroeck GV, Verbeke W, Dixon B. Determinants of consumer interest in fuel economy: Lessons for strengthening the conservation argument. Biomass and Bioenergy 2009;33:768–78.
[20] Skipper D, et al. Consumers' perceptions regarding tradeoffs between food and fuel expenditures: a case study of U.S. and Belgian fuel users. Biomass and Bioenergy 2009;33:973–87.
[21] Savvanidou E, Zervas E, Tsagarakis KP. Public acceptance of biofuels. Energy Policy 2010;38(7):3482–8.
[22] Delshad AB, Raymond L, Sawicki V, Wegener DT. Public attitudes toward political and technological options for biofuels. Energy Policy 2010;38(7):3414–25.
[23] van Vliet O, de Vries B, Faaij A, Turkenburg W, Jager W. Multi-agent simulation of adoption of alternative fuels. Transportation Research Part D: Transport and Environment 2010;15(6):326–42.
[24] Jansson C, Westerbergh A, Zhang J, Hu X, Sun C. Cassava, a potential biofuel crop in China. Applied Energy 2009;86(S1):S95–9.
[25] Shao H, Chu L. Resource evaluation of typical energy plants and possible functional zone planning in China. Biomass and Bioenergy 2008;32:283–8.
[26] Li S-Z, Chan-Halbrendt C. Ethanol production in China: potential and technologies. Applied Energy 2009;86:S162–9.
[27] Wu CZ, Yin XL, Yuan ZH, Zhou ZQ, Zhuang XS. The development of bioenergy technology in China. Energy 2010;35(11):4445–50.
[28] Tian Y, Zhao L, Meng H, Sun L, Yan J. Estimation of un-used land potential for biofuels development in China. Applied Energy 2009;86(S1):S77–85.
[29] Yang H, Zhou Y, Liu J. Land and water requirements of biofuel and implications for food supply and the environment in China. Energy Policy 2009;37:1876–85.
[30] Yong Z, Xiaojiao C, Yueming J. Study on supply chain coordination system of biomass energy. Logistics Technology 2009;28(3):114–6.
[31] Yong Z, Xiaojiao C, Yueming J. Modeling of biomass energy supply chain based on systems dynamics. Logistics Technology 2009;28(10):119–22.
[32] Shengyi P, Yong Z, Yifeng Y, Shiyan Y. A comparative and analytical study of the organizational structure of biomass supply logistics based on transaction cost. Logistics Technology 2010;29(1):106–8.
[33] Han J, Hayashi Y. Assessment of private car stock and its environmental impacts in China from 2000 to 2020. Transportation Research Part D 2008;13:471–8.
[34] Peidong Z, Yanli Y, Yongsheng T, Xutong Y, Yongkai Z, Yonghong Z, Lisheng W. Bioenergy industries development in China: dilemma and solution. Renewable and Sustainable Energy Reviews 2009;13(9):2571–9.
[35] Wen WM. Biodiesel in China. Asia Biofuels Company (BVI) Ltd., 2006-05-10.
[36] Li ZH, Luo P. The analysis of SPSS for windows. 2nd ed. Beijing, CN: Electronic Industry Press; 2005. p. 261.
[37] FOE, 2008. Public in the dark about biofuels in their petrol. Friends of the Earth. Available from: www.foe.co.uk/resource/press_releases/public_in_the_dark_about_b_15042008.htmlS.
[38] Lahmann EL. Biodiesel in Oregon: An Agricultural Perspective. Honors Baccalaureate of Science in Environmental Economics, Policy, and Management. University of Oregon; 2005.
[39] West G. Canadian attitudes toward government intervention policies in the biofuel market. In: Agricultural Institute of Canada Conference. 2007.
[40] Romm J. The car and fuel of the future. Energy Policy 2006;34(17):2609–14.
[41] Bomb C, McCormick K, Deurwaarder E, Kåberger T. Biofuels for transport in Europe: Lessons from Germany and the UK. Energy Policy 2007;35:2256–67.